

# **Richard W. Hamming**



## **Learning to Learn**

The Art of Doing Science and Engineering

### **Session 6: Artificial Intelligence I**



# Can Machines Think?

## Underlying Problems:

- Your personal ego
  - *Assets machines possess that you don't*
- Your religion
  - *Christian: God creating man in own image*
  - *Puts you in competition with God*
- Formulas vs. thinking
  - *e.g. chess programs*



# **What the universe is...**

**Greek: Democritus - "all is atoms and void"**

- **classical view of physics**

**What about souls?**

- **How can souls change what is going to happen?**
- **Can lead to discussions between the psychic world and the physical world**



# Expectations:

**That you can answer the question:  
“Do machines think?”**

- What you think is not important
- What is is your ability to intelligently express your opinions clearly

# **Why should I want to do this?**



- **If you believe that there is a fundamental difference between humans & machines, then you will be hesitant to use computers and the world will become highly computerized around you**
- **If you believe that machines can think, then it is likely you will attempt to misuse the capabilities of computers which will be detrimental to your career.**
- **The goal is to believe and disbelieve at the same time.**

# History of Computer Thinking



## RAND

- **Playing games - very structured environment. Object and rules are clear. Success can be measured. (e.g. winning at chess)**
- **Logic problems (missionaries & cannibals)**
- **General problem solvers (list processing)**
- **Expert systems (rule-based logic)**



# Expert Systems

- **Gather experts & interview them**
  - **Figure out how they make decisions**
  - **Encode these decision rules**
  - **Machine will then be able to solve the problem**
- 
- **Similar to decision tree logic found within some medical texts (various symptoms yield a diagnosis)**



# What if an error occurs?

- **Doctors are human and can use “due prudence” to avoid legal obligations**
- **If a machine gives an error, who do you sue?**
  - The programmers? The company that sold you the service? Obviously can't sue the machine.
  - A program can be debugged (find bad decisions). A doctor is not so fortunate (“to err is human”).
- **If a machine did diagnose you, who would write the prescription?**



# Can Machines Think (ala AI)?



- **What burdens can be put on the machine?**

- Muscle-power (power tools, robots, etc)
- So why not brain-power?

- **Poorly stated problem**

- The real questions is: "Can YOU write a program to make the machine think?"



# What is a machine?

- **Can't be organic?**
  - Wooden machines? Nervous systems as memory devices.
- **Jesuit priest's answer: Humans can think and machines can't.**
  - The gap is getting smaller.
  - Definitions are arbitrary – and negative definitions can leave you open for a contradiction in the future.
  - Try a positive definition vs a negative one.



# Ego and thinking...

## Ego says:

- Rocks & trees can't think. Maybe animals.
- Einstein & Newton thought, but you're not at their level.
- Need to have a definition that proves that you can think

# Souls...



- **If we are different from the rest of the living world... what is it?**
  - Ex: cats – self-aware and self-conscious; likely that they can think
  - One-celled animals can figure out what is food and can be trained. Thus, thinking not a function of a nervous system.

# **The whole is greater than the sum of its parts...**



- **Believe molecules have no friction  
But large assemblies of molecules  
do have friction.**
- **Thus large assemblies can have  
properties that their individual parts  
do not possess**



# The failure of AI

- **Suggests that machines can't think**
- **Teller - wave-particle duality**
  - Quantum mechanics: light is like both waves & particles
- **Davis & Germer:**
  - Electrons have wave-like properties
- **Two-slit experiment (wave particle duality)**
  - QM professors can't explain why this happens



## **But why can't you think it?**

- **There are creatures that can see, smell, and hear things beyond our range**
- **We are built the way we are**
- **Then why are we offended that we cannot think in certain ways.**
- **Maybe humans cannot think in QM**



# **Living with Ambiguity**

**Great scientists tolerate ambiguity.**

**Everything is not true or false; yes or no.**

**Life is in shades of gray...**

**Thus...**

**Machines can think and they can't.**

**Light is a particle and a wave.**





# **Souls**

**How much does a soul weigh?**

**What is a soul?**

**Self-awareness - I believe it's more than just molecules banging together.**

**Thus, I believe, like Teller, that we are both these things (molecules & spirit).**



# More history...

**Aristotle: Earth and Heavens are different and under different rules**

**Newton: Moon and apple motion both responding to gravity (under the same rules)**

**Chemistry: Originally believed organic compounds cannot be made by man. Belief is now the reverse, man can create anything within a human body “inside a test tube.”**

**Enough success can change belief system.**



- **Something beyond the molecules that enables you to think. But if you don't know what that is, how can you program it into a machine?**

**Definition of “meaning” like definition of “time” - understood, but indefinable. Then how can a machine deal with “meaning?” All assertions without demonstrations.**

# Life depending on a machine



- Pacemakers
- Emergency wards - you are monitored by computer... better than a nurse
- Airplanes - better airplanes are unstable and rely on the computer as much as pilot
- Stoplights - works better than a policeman



# What can computers do?

- **Tic-tac-toe: 4x4 matrix**
  - Legal moves, strategy to win & to block, advantages and forcing player into disadvantaged moves
  - Heuristic rules; no fixed rules
- **Chess (Claude Shannon)**
  - How to play chess (what moves are better than others, evaluation and worth of pieces & moves)
  - Codified into machines
  - Now machines can generally beat most players



## Checkers (Art Samuels)

- Blocked pieces, control of the center
- Constants of evaluation
- Perturbed the formula and had the machine play against itself (1<sup>st</sup> vs 2<sup>nd</sup> formula). Found which formulas were better than others and repeated (changing various parms) until “best” formula found.
- Machine beats human checkers champion (with 40 years of experience).

# Experience and programming



- **Did the machine learn from experience?**
  - If programmed in – isn't that what school is all about?
- **Machine started out a poor player and “learned” from its experiences to become an expert checkers player**
- **Intelligence – isn't that learning from experience?**



# Artificial Intelligence

- **How would I answer these questions:**
  - What would I expect as a test that a machine can learn or not?
  - What will I accept as the difference between man and machine (beyond personal/religious biases)?
- **Until you can answer these questions, you will not make much headway in AI & determining “can machines think” or can programs be written to exhibit thinking.**





# Free Will & Ambivalence

- **Teachers believe that “if only I can say things in the right way, then you will have to understand”**
- **Similar to parents & their children:**
  - “If only I raise them right, they would behave right.”
  - Acts as child has not free will
  - Parents will then blame bad behavior on child’s free will.
  - Society often blames the parents for a child’s behavior
- **Similar to view of crime & environment**
  - “Fix” the environment and people will behave – no free will